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Сведения об авторах:

Гасымов Ф.М. – кандидат сельскохозяйственных наук, старший научный сотрудник отдела садоводства ЮУНИИСК – филиала ФГБНУ УрФАНИЦ УрО РАН, ФГБНУ «Уральский федеральный аграрный научно-исследовательский центр Уральского отделения Российской академии наук», 454902, г. Челябинск, ул. Гидрострой, 16, тел. 89067705312, e-mail: lstpk@mail.ru

Галимов В.Р. – научный сотрудник отдела садоводства ЮУНИИСК – филиала ФГБНУ УрФАНИЦ УрО РАН, ФГБНУ «Уральский федеральный аграрный научно-исследовательский центр Уральского отделения Российской академии наук», 454902, г. Челябинск, ул. Гидрострой, 16, тел. 89067705312, e-mail: lstpk@mail.ru

Лезин М.С. – кандидат сельскохозяйственных наук, заведующий Челябинским государственным плодово-ягодным сортоиспытательным участком, 456680, Челябинская область, Красноармейский район, д. Шибаново, e-mail: lezin-misha@mail.ru

Gasimov F.M. – Candidate of Agricultural Sciences, Senior Researcher of the Department of Horticulture of YuUNIISK – a branch of the FGBNU UralFANITS UB RAS, FGBNU "Ural Federal Agrarian Research Center of the Ural Branch of the Russian Academy of Sciences", 454902, Chelyabinsk, st. Gidrostroy, 16, tel. 89067705312, e-mail: lstpk@mail.ru

Galimov V.R. – Researcher of the Department of Horticulture of YuUNIISK – a branch of the FGBNU UralFANITS UB RAS, FGBNU "Ural Federal Agrarian Research Center of the Ural Branch of the Russian Academy of Sciences", 454902, Chelyabinsk, st. Gidrostroy, 16, tel. 89067705312, e-mail: lstpk@mail.ru

Lezin M.S. – Candidate of Agricultural Sciences, Head of the Chelyabinsk State Fruit and Berry Variety Testing Plot, 456680, Chelyabinsk region, Krasnoarmeysky district, Shibanovo village, e-mail: lezin-misha@mail.ru

Гасымов Ф.М. – ауылшаруашылық ғылымдарының кандидаты, ФГБНУ «Ресей ғылым академиясының Орал филиалының Орал федералды аграрлық ғылыми орталығы», 454902, Челябинск қ., Гидрострой, 16, тел. 89227058684, e-mail: lstpk@mail.ru

Галимов В.Р. – бау-бақша бөлімінің ғылыми қызметкері, ФГБНУ «Ресей ғылым академиясының Орал филиалының Орал федералды аграрлық ғылыми орталығы», 454902, Челябинск қ., Гидрострой, 16, e-mail: lstpk@mail.ru

Лезин М.С. – ауыл шаруашылығы ғылымдарының кандидаты, Челябі мемлекеттік жеміс-жидек сорттарын сынау учаскесінің бастығы, 456680, Челябі облысы, Красноармейский ауданы, Шибаново ауылы, e-mail: lezin-misha@mail.ru

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EVALUATION OF THE BREEDING VALUE OF HOLSTEIN BULLS OF AMERICAN BREEDING BASED ON THE BLUP METHOD IN THE CONDITIONS OF THE KOSTANAY REGION

Papusha N.V. – Candidate of Agricultural Sciences, Associate Professor of the Department of Animal Products Production Technology Kostanay Regional University named after A. Baitursynov.

Muratov D.K. – Master's student of specialty 7M08201 – Technology of production of animal products, Kostanay Regional University named after A. Baitursynov.

This article discusses the use of the BLUP method for accurate and objective calculation of the indices of the breeding value of Holstein bulls, as well as the comparison of indicators obtained by processing data on the productivity of cows in the conditions of the Kostanay region with the indicators of the daughters of American breeding. The indices of the breeding value of Holstein bulls were calculated taking into account the formed database on the productivity of their offspring in the conditions of the Kostanay region, while 11 bulls were characterized as deteriorators, and the remaining 6 as improvers. A comparison of the breeding value indices with the offspring of bulls of local and American breeding by determining the coefficient of rank correlation between the results obtained in the conditions of Northern Kazakhstan and the indices known in the USA showed that despite the high productivity indicators of their daughters, only 26.7% of them were able to show their breeding qualities both in the native conditions of North America and in the conditions of

farms of Kostanay region. Such bulls include ROYOLA ALTADONNIE 511HO10522, FARNEAR-TBR ALTAVALON-ET 011HO10360 and NO-FLA ALTADANNO-ET 011HO11198. The bulls studied included R-E-W ALTA BAYSIDE 11HO08600, NO-FLA ALTADANNO-ET 011HO11198, MORNINGVIEW ALTA TOYOTA 511HO10079, FARNEAR-TBR ALTAVALON-ET 011HO10360, ROYOLA ALTADONNIE 511HO10522 and BOMAZ ALTAPHONIC-ET 511HO10997.

Keywords: BLUP, Holstein breed, breeding value index.

ОЦЕНКА ПЛЕМЕННОЙ ЦЕННОСТИ БЫКОВ ГОЛШТИНСКОЙ ПОРОДЫ АМЕРИКАНСКОЙ СЕЛЕКЦИИ НА ОСНОВЕ МЕТОДА BLUP В УСЛОВИЯХ КОСТАНАЙСКОЙ ОБЛАСТИ

Папуша Н.В. – кандидат сельскохозяйственных наук, ассоциированный профессор кафедры технологии производства продуктов животноводства, Костанайский региональный университет им.А.Байтұрсынова.

Муратов Д.К. – обучающийся магистратуры по специальности 7M08201 – Технология производства продуктов животноводства, Костанайский региональный университет им.А.Байтұрсынова.

В данной статье рассматривается использование метода BLUP для точного и объективного вычисления индексов племенной ценности быков голштинской породы, а также сравнение показателей, полученных при помощи обработки данных о продуктивности коров в условиях Костанайской области с показателями дочерей американской селекции. Был проведен расчет индексов племенной ценности быков голштинской породы с учетом сформированной базы данных о продуктивности их потомства в условиях Костанайской области, при этом 11 быков охарактеризованы как ухудшатели, а остальные 6 как улучшатели. Сравнение индексов племенной ценности с потомством быков местной и американской селекции путем определения коэффициента ранговой корреляции между полученными результатами в условиях Северного Казахстана и известными в США индексами показало, что несмотря на высокие показатели продуктивности их дочерей только лишь 26,7% из них смогли проявить свои племенные качества как в родных условиях Северной Америки, так и в условиях хозяйства Костанайской области. К таким быкам относятся ROYOLA ALTADONNIE 511HO10522, FARNEAR-TBR ALTAVALON-ET 011HO10360 и NO-FLA ALTADANNO-ET 011HO11198. Среди исследуемых быков были отмечены R-E-W ALTA BAYSIDE 11HO08600, NO-FLA ALTADANNO-ET 011HO11198, MORNINGVIEW ALTA TOYOTA 511HO10079, FARNEAR-TBR ALTAVALON-ET 011HO10360, ROYOLA ALTADONNIE 511HO10522 и BOMAZ ALTAPHONIC-ET 511HO10997.

Ключевые слова: BLUP, голштинская порода, индекс племенной ценности

ҚОСТАНАЙ ОБЛЫСЫ ЖАҒДАЙЫНДА BLUP ӘДІСІ НЕГІЗІНДЕ АМЕРИКАНДЫҚ СЕЛЕКЦИЯНЫҢ ГОЛШТЕЙН ТҰҚЫМЫ БҰҚАЛАРЫНЫҢ АСЫЛ ТҰҚЫМДЫҚ ҚҰНДЫЛЫҒЫН БАҒАЛАУ

Папуша Н. В. – Ауыл шаруашылығы ғылымдарының кандидаты, мал шаруашылығы өнімдерін өндіру технологиясы кафедрасының қауымдастырылған профессоры А. Байтұрсынов атындағы Қостанай өңірлік университеті.

Мұратов Д.К. – 7M08201 – Мал шаруашылығы өнімдерін өндіру технологиясы мамандығының магистратура білім алушысы, А. Байтұрсынов атындағы Қостанай өңірлік университеті.

Бұл мақалада голштейн тұқымы бұқаларының асыл тұқымдық құндылығының индекстерін дәл және объективті есептеу үшін BLUP әдісін қолдану, сондай-ақ Қостанай облысы жағдайында сиырлардың өнімділігі туралы деректерді американдық селекция қыздарының көрсеткіштерімен өңдеу арқылы алынған көрсеткіштерді салыстыру қарастырылады. Қостанай облысы жағдайында олардың ұрпақтарының өнімділігі туралы қалыптасқан деректер базасын ескере отырып, Гольштейн тұқымы бұқаларының асыл тұқымдық құндылығының индекстеріне есептеу жүргізілді, бұл ретте 11 бұқа нашарлатушы, ал қалған 6 бұқа жақсартушы ретінде сипатталды. Солтүстік Қазақстан жағдайында алынған нәтижелер мен АҚШ-та белгілі индекстер арасындағы дәрежелік корреляция коэффициентін анықтау арқылы асыл тұқымдық құндылық индекстерін жергілікті және американдық селекциядағы бұқалардың ұрпақтарымен салыстыру олардың қыздарының өнімділігінің жоғары көрсеткіштеріне қарамастан, олардың тек 26,7%-ы ғана өздерінің асыл тұқымдық қасиеттерін Солтүстік Американың туған жағдайында да, сол сияқты Солтүстік Американың туған жағдайында да көрсете алғанын көрсетті. Қостанай облысының шаруашылықтары. Мұндай бұқаларға ROYOLA ALTADONNIE 511HO10522, FARNEAR-TBR ALTAVALON-ET 011HO10360 және NO-FLA ALTADANNO-ET 011HO11198 кіреді. Зерттелген бұқалардың ішінде R-E-W ALTA BAYSIDE 11HO08600, NO-FLA ALTADANNO-ET 011HO11198, MORNINGVIEW ALTA TOYOTA

511HO10079, FARNEAR-TBR ALTAVALON-ET 011H010360, ROYOLA ALTADONNIE 511HO10522 және де BOMAZ ALTAРHONIC-ET 511HO10997.

Түйінді сөздер: BLUP, голштейн тұқымы, асыл тұқымдық құндылық индексі

Introduction. At the present stage of development of breeding work in the world, the main criteria for the selection of breeding bulls is the objectivity and reliability of the obtained indicators of breeding value. An accurate and complete forecast will allow farmers to reduce possible economic risks when choosing genetic material. The breeding value of a bull is precisely the predicted data, expressed by a deviation for the better or for the worse comparing the average value in the herd [1]. K.Zhumanov in his work notes that methods of determining the breeding value in our country by comparing the productivity of a daughter-a peer, or a daughter-a breed standard do not meet modern requirements and cannot give a complete picture of the feasibility of using a breeding bull, or its genetic material in the farm. However, in Western countries, complex mathematical models are successfully used to calculate this indicator, and one of such methods is the method of constructing the best linear unbiased prediction (BLUP) [2, pp.155-156].

Scientific novelty: in the conditions of the economy of the northern region of the Republic, a study was conducted of the index of breeding value of Holstein bulls, taking into account a complex of various characteristics, including the productive qualities of daughters raised in these conditions. Based on the BLUP method, the principles of calculating the predicted indices of breeding value of various countries, such as TPI (USA), LPI (Canada), RZG (Germany), etc. are constructed. The use of this method makes it possible to assess the breeding value of the animals being tested, despite the observed paratypical differences in the populations where their offspring are used.

Theoretical and practical significance: The introduction of the BLUP breeding value index has become an important achievement in the field of dairy cattle breeding. The conducted research will allow to reveal in detail the value of the indicators of this index in the selection of bulls-producers. V.Y. Khainatsky defines the BLUP method as a statistical method of calculation, which takes into account the influence of phenotypic and genotypic factors. This model is used as a means of describing data, which includes various paratypical factors that can have a great impact on the productive qualities of cows. Different types of models are used for calculations, for example, the so-called paternal model was designed to evaluate animals according to the qualitative indicators of their offspring [3, p.21].

The BLUP method takes into account both environmental and genotype factors affecting the variability of the studied traits. The simultaneous assessment of these factors provides a reliable, unbiased forecast of the evaluation of the breeding value of bulls, thereby increasing the probability of selecting producers with the best hereditary characteristics [4, pp.94-96].

The application and adaptation of the BLUP method in breeding work in the conditions of Kazakhstan will allow for better analysis and planning of breeding work, as well as significantly increase its effectiveness. The breeding value calculated by the BLUP method shows by what amount the probable genotype of the tested producers deviates according to the studied trait from the average genetic value of the other bulls involved in the assessment. S.N. Kharitonov also notes that, unlike other methods of assessing breeding value, the BLUP method differs in a very important parameter - it is statistical non-bias. Statistical bias in calculations is possible under the condition of simultaneous fixation of the breeding value and the influence of paratypical factors [5, p.77].

Objective: To determine the breeding value of Holstein bulls using the BLUP method, to establish a correlation between the productivity of Holstein cows raised in Northern Kazakhstan with the daughters of American breeding.

Tasks:

1. Calculate the indices of breeding value of bulls, taking into account the formed database on the productivity of the offspring of the Holstein breed in the conditions of the Kostanay region;
2. To compare the indicators of the calculated indices of breeding value with the indices obtained from the certificates of these bulls and calculate the coefficient of rank correlation;
3. Identify the best breeding bulls for further use on the farm and form recommendations for improving breeding work.

The material and methodology of the study. The study was conducted on the basis of data obtained during the study of the productivity of Holstein cows in Saryagash LLP, Kostanay region and breeding certificates of Holstein bulls from the AltaGenetics company website.

The breeding value indices were calculated using the special BLUP SM (Sire Model) software in the RStudio environment (Fig.1). This model allows us to take into account such factors as independent variables - in this case, the effect of the year of birth of cows, the father effect and the residual effect, which can influence the dependent variable - milk yield.

The model describes the situation in the population, which takes into account the influence of environmental factors and heredity on the studied indicator and how much its effectiveness will depend. The year of birth of cows (year) was chosen as a paratypical factor, and the selected indicator is milk yield (y).

```

69 SSR <- t(b1)%*%Xy # Регрессионные суммы квадратов bXy<-t(b1)%*%Xy
70
71 u1<-g[(rx2+1):(rx2+rZ)]
72 Zy<-Y[(rx2+1):(rx2+rZ)]
73 uZy<-t(u1)%*%Zy
74
75 SSE <- SST-SSR-uZy # Остаточный эффект
76
77 sigmae<-SSE/(n-(rx2)) # остаточная вариация
78
79 u2<-2*u1
80 osh2 <- diag(Minv)*sigmae
81 osh <- sqrt(osh2)
82
83 uu <- t(u1)%*%u1
84 diagMinv <- diag(Minv)
85 trc22 <- sum(diagMinv[rx2+1:rZ]) # след матрицы C22
86
87 sigmas <- (uu+sigmae*trc22)/rZ # факториальная вариация
88
89 kn <- sigmae/sigmas
90 kn <- kn[1:1]
91 pr <- k-kn
92
93 PEV <- diagMinv*sigmae
94 SEP <- sqrt(PEV)
95 REL <- 1-PEV/sigmas
96 Rez <- cbind(g,PEV,REL,Y)
97
98
99 write.table(Rez,"C:/Users/Дос/Desktop/P/F5GOLRES.D.txt")
    
```

Figure 1 - The process of calculating the breeding value index in the R Studio environment

The data for the study were obtained from the primary zoo technical documentation of the farm and the republican information and analytical system (IAS), where 17 bulls of American breeding were selected, as well as 220 daughters belonging to the Holstein breed, while the main criteria were the number of offspring per bull and their milk yield. The study used indices of the breeding value of the same bulls from the Alta Genetics website, in order to compare them.

The rank correlation coefficient was calculated using Spearman's formula, it has the following form:

$$r = 1 - \frac{6\sum d^2}{n(n^2-1)} \tag{1}$$

Where:

- r – rank correlation coefficient
- $\sum d^2$ - sum of squares of rank difference
- n – number of observations

Research results. Before starting the calculations, data processing was carried out for the correctness of the program, respectively, each bull and their daughters were left with only a numerical designation.

The results of calculations of breeding value indices are stored in a separate text document (Table 1), where the years of birth of cows are indicated as a paratypical factor, the breeding value index itself (NM\$), the reliability of the calculation results (Rel) and the total milk yield of daughters for each bull (y) as a selectable trait.

Table 1 – The results of calculating the breeding value index according to the BLUP method according to the productivity data of the daughters of the Holstein breed in the conditions of the Kostanay region

ID of bulls (sire)	Breeding value index (NM\$)	Reliability indicator (Rel)	Total milk yield by daughters (y)
011HO08230	-303,07	0,375647	92966
011HO08385	-20,4688	0,269719	64039,6
011HO08600	47,58927	-0,15388	16981
011HO09956	-10,3875	0,200095	54047
011HO10631	-162,646	0,414412	134350
011HO10663	-99,0375	0,179033	43782
011HO11198	218,4012	0,426708	146299
011HO11227	-29,0671	0,310971	89828,4
511HO09497	-73,4817	0,029267	20299
511HO09861	-24,3624	0,301229	74475
511HO10079	26,18088	0,457417	136698
011HO10360	231,2318	0,326992	96441,9
511HO10500	-27,9586	0,180762	45344
511HO10522	128,1886	0,286232	88660,4
511HO10676	-60,7519	0,31466	77792,4
511HO10997	227,1007	-0,01414	21980
511HO11112	-77,6892	0,268357	62242

As can be seen from Table 1, a larger number of offspring provides a higher confidence score (Rel), a negative value of this indicator indicates a low number of studied individuals in the offspring, in this case there is a small number of daughters in bulls NO-FLA ALTADANNO-ET 011HO11198 and ROYOLA ALTADONNIE 511HO10522 and, accordingly, a low confidence score. The breeding value index (NM\$) indicates whether a certain bull is an improver (positive index value), or a degrader (negative index value) in comparison with other bulls in the farm. In this case, out of 17 bulls, 11 are degraders according to their negative value of the BLUP score, the remaining 6 received a positive value, which characterizes them as improvers. The indicator of total milk yield for daughters indicates that most of the milk yield falls on cows whose fathers were characterized as improvers.

Table 2 - Comparison of the indices of breeding values calculated according to the productivity of Holstein cows, as well as data on the productivity of daughters of foreign breeding

№	Nickname and ID of the bull	Linear affiliation	Breeding value index based on the results of calculations	Breeding value index according to AltaGenetics
1	LADYS-MANOR AUGUSTA 011HO08230	R.Sovering	-303,07	-264
2	MR MINISTER 011HO08385	W.B.Ideal	-20,4688	54
3	R-E-W ALTA BAYSIDE 011HO08600	W.B.Ideal	47,58927	-148
4	MORSAN ALTALOCKLYN 011HO09956	W.B.Ideal	-10,3875	2
5	DINOMI ALTADETROIT-ET 011HO10631	W.B.Ideal	-162,646	85
6	SCHILLVIEW ALTA UNITED 011HO10663	R.Sovering	-99,0375	116
7	NO-FLA ALTADANNO-ET 011HO11198	W.B.Ideal	218,4012	111
8	ALTAWISEMAN-ET 011HO11227	W.B.Ideal	-29,0671	-381
9	GLEN-TOCTIN ALTAOMAX- ET 511HO09497	W.B.Ideal	-73,4817	-10

10	ALTA SAMUARI 511HO09861	W.B.Ideal	-24,3624	-50
11	MORNINGVIEW ALTA TOYOTA 511HO10079	W.B.Ideal	26,18088	-173
12	FARNEAR-TBR ALTAVALON-ET 011H010360	W.B.Ideal	231,2318	4
13	DE-SU ALTAGATOR-ET 511HO10500	R.Sovering	-27,9586	-102
14	ROYOLA ALTADONNIE 511HO10522	R.Sovering	128,1886	288
15	AMMON-PEACHEY TRADER 511HO10676	W.B.Ideal	-60,7519	308
16	BOMAZ ALTAPHONIC-ET 511HO10997	W.B.Ideal	227,1007	-68
17	ROSYLANE-LLC ALTASTEWART-ET 511HO11112	W.B.Ideal	-77,6892	414

In Table 2, we can see a strong difference in the indices of breeding value in almost every animal, however, the LADYS-MANOR AUGUSTA 011HO08230 bull of the Reflection Sovering line has relatively similar results for both groups of offspring. Also worth noting among the bulls are R-E-W ALTA BAYSIDE 11HO08600, NO-FLA ALTADANNO-ET 011HO11198, MORNINGVIEW ALTA TOYOTA 511HO10079, FARNEAR-TBR ALTAVALON-ET 011H010360, ROYOLA ALTADONNIE 511HO10522 and BOMAZ ALTAPHONIC-ET 511HO10997, which were characterized as improvers according to their value of the index of breeding value, however, only bulls ROYOLA ALTADONNIE 511HO10522 FARNEAR-TBR ALTAVALON-ET 011H010360 and NO-FLA ALTADANNO-ET 011HO11198 were able to show their genetic potential both in Kazakhstan and in North America. It is worth noting that despite the positive value of the breeding value index according to AltaGenetics, the bulls ROSYLANE-LLC ALTASTEWART-ET 511HO11112, AMMON-PEACHEY TRADER 511HO10676, SCHILLVIEW ALTA UNITED 011HO10663, DINOMI ALTADETROIT-ET 011HO10631 and MR MINISTER 011HO08385 in the conditions of the Kostanay region economy received a negative index value, which characterizes them as degraders, respectively, the use of genetic material of these bulls is impractical. The same applies to the bulls LADYS-MANOR AUGUSTA 011HO08230, ALTAWISEMAN-ET 011HO11227, GLEN-TOCTIN ALTAOMAX-ET 511HO09497, ALTA SAMUARI 511HO09861 and DE-SU ALTAGATOR-ET 511HO10500, which are characterized as degraders in both cases.

The correlation coefficient was calculated according to the breeding value index (NM\$) to find out whether the bulls producers are able to show their breeding value in relatively different conditions of lactation of their daughters.

Substituting the finished data after ranking, we determine the coefficient of rank correlation according to Spearman's formula (1) between cows grown in the conditions of the Kostanay region farm and cows of American breeding:

$$r = 1 - \frac{6 \cdot 598}{17(17^2 - 1)} = 1 - 0,733 = 0,267$$

The rank correlation coefficient indicates that only 26.7% of the studied bulls of American breeding showed their breeding qualities in the conditions of northern Kazakhstan, which indicates clear differences in paratypical factors and environmental conditions.

Conclusion. According to the tasks set, the following results were obtained:

1. The indices of breeding value of Holstein bulls were calculated taking into account the formed database on the productivity of their offspring in the conditions of the Kostanay region, while the main part of the bulls, namely 11 heads received a negative index of breeding value, which characterizes them as degraders in the conditions of this farm, and the remaining 6 received a positive index of breeding value.

2. A comparison of the indicators of the breeding value index with the offspring of bulls of local and American breeding by determining the correlation coefficient according to the indices of breeding value showed that despite the high productivity indicators, only 26.7% of them were able to show their breeding qualities both in the native conditions of North America and in the conditions of the Kostanay region economy. These bulls include ROYOLA ALTADONNIE 511HO10522, FARNEAR-TBR ALTAVALON-ET 011H010360 and NO-FLA ALTADANNO-ET 011HO11198.

3. Among the bulls studied, R-E-W ALTA BAYSIDE 11HO08600, NO-FLA ALTADANNO-ET 011HO11198, MORNINGVIEW ALTA TOYOTA 511HO10079, FARNEAR-TBR ALTAVALON-ET 011H010360, ROYOLA ALTADONNIE 511HO10522 and BOMAZ ALTAPHONIC-ET 511HO10997 were

noted, which were characterized as improvers according to their index value of breeding value. The use of the genetic material of these bulls will allow to comprehensively improve the productivity of the herd.

Studies based on milk productivity indicators in daughters of different ages using the BLUP method have objectively demonstrated the possibility of this method when calculating such a parameter as breeding value. Carrying out similar calculations for all parameters defined for the dairy industry to increase the efficiency of all breeding work on the breeding value of the producer from the point of view of the quality of the offspring is impossible without the use of modern methods of assessing the breeding value, which makes it possible to determine the value of bulls with high reliability and predict the productivity of offspring.

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Information about the authors:

Папуша Наталья Владимировна – кандидат сельскохозяйственных наук, ассоциированный профессор (доцент) кафедры «Технология производства продуктов животноводства», Костанайского регионального университета им.А.Байтурсынова, 110000 г.Костанай, ул.Маяковского, 99/1. тел. 8-705-411-51-71 e-mail: Natali.P82@inbox.ru.

Муратов Досмухамед Куатұлы – магистрант специальности 7M08201 – «Технология производства продуктов животноводства», Костанайский региональный университет им. А.Байтурсынова, 110000, г.Костанай, ул. Маяковского, 99/1, тел 8-708-577-23-78, e-mail: D_O_S1999@mail.ru.

Papusha Natalya Vladimirovna is the candidate of agricultural sciences, the associate professor of "Production Technology of Livestock Products" department, Kostanay regional university named after A. Baitursynov, 110000 Kostanay city, Mayakovsky St. 99/1. ph. 8-705-411-51-71 of e-mail: Natali.P82@inbox.ru.

Muratov Dosmuhamed Kuatuly – master's degree student in the specialty 7M08201-Technology of production of animal products, Kostanay regional university named after A. Baitursynov, 110000 Kostanay city, Mayakovsky St. 99/1, tel. 8-708-577-23-78, e-mail: D_O_S1999@mail.ru.

Папуша Наталья Владимировна – А.Байтұрсынов атындағы Қостанай өңірлік университетінің, мал шаруашылық өнімдерін өндіру технологиясы кафедрасының доценті ауылшаруашылығы ғылымдарының кандидаты, 110000 Костанай қ. Маяковский көшесі 99/1 тел: 8-705-411-51-71 e-mail: natali.p82@inbox.ru.

Муратов Досмухамед Куатұлы – А. Байтұрсынов атындағы Қостанай өңірлік университетінің 7M08201 – мал шаруашылығы өнімдерін өндіру технологиясы мамандығы бойынша магистратурада білім алушы, 110000, Маяковский көшесі 99/1, тел 8-708-577-23-78, e-mail: D_O_S1999@mail.ru.